

To: Nuclear Physics Experiment Scheduling Committee
From: Steffen Strauch, Rolf Ent, Ron Ransome, Paul Ulmer
(Spokespersons E03-104)
Subject: Scheduling of E03-104
Date: September 29, 2005

We would like to request that experiment E03-104 be scheduled. This experiment, *Probing the Limits of the Standard Model of Nuclear Physics with the $^4\text{He}(\vec{e}, e'\vec{p})^3\text{H}$ Reaction*, has been approved for 18 days and consists of measuring the recoil proton polarizations after scattering polarized electrons from ^4He . The ratio of the transverse and longitudinal helicity-dependent polarization components is expected to be sensitive to the ratio of the proton electromagnetic form factors, G_E/G_M , in the dense nuclear medium.

Experiment E03-104 is an extension of E93-049 [1]. The latter experiment found reasonable agreement between data and calculation only after inclusion of medium-modified nucleon form factors as predicted by the quark-meson coupling (QMC) model [2]. Although, in principle, conventional DWIA calculations could be improved at the cost of added complexity, the inclusion of medium-modified nucleons may offer a more economical description of nuclei. However, the uncertainties of the data do not yet allow a definite conclusion.

The new experiment will measure the polarization ratio at Q^2 values of 0.8 and 1.3 (GeV/c) 2 with uncertainties roughly a factor of two smaller than for E93-049 mostly due to the higher beam currents and beam polarizations expected (see Fig. 1). In addition, E03-104 includes calibration runs to better determine the recoil polarimeter false asymmetries. These features of E03-104 will allow a much improved measurement and should provide one of the most stringent tests of the standard model of nuclear physics.

There is substantial and growing interest within the theoretical community in obtaining improved data for this reaction. In particular, we now have new microscopic calculations by R. Schiavilla *et al.* [3]. These results challenge the current interpretation of the experimental data in terms of medium-modified form factors; however, at the expense of including not well constrained terms in the parameterization of the final-state interaction. The expected high-precision data on the induced polarization will be crucial to shed more light on this part of the reaction mechanism. We also now have Glauber based calculations by the group of Ryckebusch [4], and a chiral soliton-model calculation of the in-medium form factors by Smith and Miller

[5].

The experiment is fully compatible with the presently obtained Hall A parameters and as such does not require large amounts of overhead to install or remove experimental apparatus. The experiment requires roughly 6 days at 1.6 GeV and 12 days at 2.4 GeV, with beam currents up to 100 μ A. However, there is a large flexibility in the precise value of these energies; e.g. 6 days at 2 GeV and 12 days at 3 GeV would still be acceptable.

We have, among us, extensive experience in Hall A, from participation in the commissioning of the experimental equipment and in actual production runs, including similar polarization transfer experiments on ^1H (E93-027), ^{16}O (E89-033) and, of course, the previous ^4He experiment (E93-049). Many of the members of the collaboration are local, and as such can play a large role in this experiment.

References

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- [3] R. Schiavilla *et al.*, Phys. Rev. Lett. **94**, 072303 (2005).
- [4] P. Lava, J. Ryckebusch, B. Van Overmeire and S. Strauch, Phys. Rev. C **71**, 014605 (2005).
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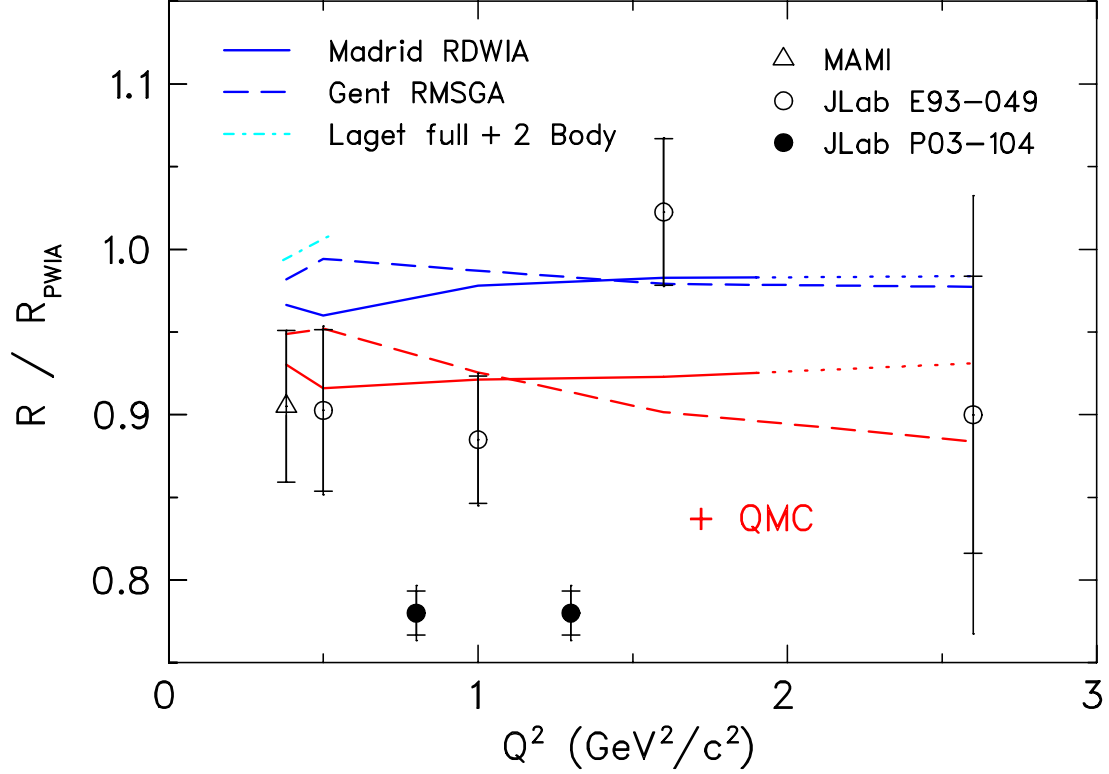


Figure 1: Existing data from Mainz and JLab along with anticipated uncertainties from experiment E03-104. R is the ratio of transverse to longitudinal polarization of the recoiling protons in ^4He compared to the same ratio for ^1H . The data are compared to calculations by the Madrid and Ghent groups, with and without including in-medium modifications as predicted by a quark-meson coupling model (QMC); and at $Q^2 < 0.5$ (GeV/c)² only, to Laget's full calculation, including two-body currents. Lines connect the acceptance-averaged theory calculations. See Ref. [1] for further details.